Operator Interface for Robotic Applications

Developer: Carnegie Mellon University
Contract Number: DE-AR21-96MC33078
Crosscutting Area: Robotics

Deactivation & Decommissioning FOCUS AREA

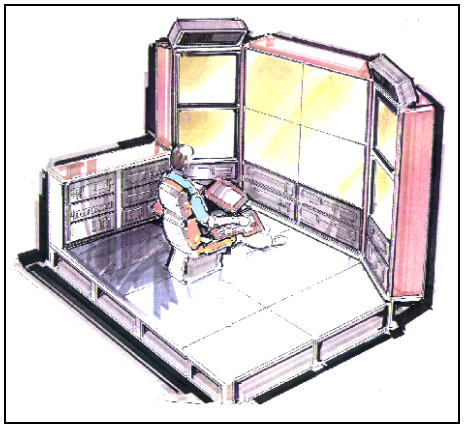
Problem:

Human operators will play a central role in the Department of Energy's (DOE's) environmental restoration agenda, focussing on such activities as deactivation and decommissioning (D&D), mixed waste cleanup, and waste tank remediation operations. The need for remote equipment to accomplish the cleanup requires the use of remote operator control station interfaces in order to remove the operator(s) from the hazardous work area.

Operating or supervising remote equipment is a complex, tiring and non-intuitive activity with major impact on operator productivity, operator errors, job quality, and usage comfort. Operators will need to be able to configure their own interface displays, combining video, computer-graphics, and input-control devices in a configuration that best suits the task at hand and their personal preference. This will optimize operator productivity and minimize errors, while insuring the quality of a cleanup task over a full shift. Most control interfaces used for remote equipment operations are not designed or configured to allow the operator full control over what, where and how to size video and graphics imagery to be displayed, the type and location of control buttons/joysticks, or the type, location or arrangement of any visual/textual status or remote system feedback information.

Hence the need arose to develop a very versatile operator interface system in order to enable operators to (i) control various remote systems with a single customized hardware/software interface to suit each remote system and/or operator, (ii) to train operators in the tele-operated or supervisory control of remote systems, (iii) resolve man-machine interface issues during equipment acceptance testing or training, and (iv) test and qualify novel software and hardware interface systems.

Solution:



An integrated and reconfigurable operator control station, dubbed Robocon, was built with integrated state-of-the-art display, computing, interface and communication hardware and software. The software and hardware architecture lends itself to easy modification, ranging from software-driven menus and display configurations, adaptation to different operator preferences, and reconfiguration for interfacing different remote work/process-systems that can all be controlled from this single-console station. This enables easy ergonomic testing, control display mode configuration and operator training sessions.

The entire system is configured to optimize the information display and operational efficiency of a human operator controlling or supervising remote systems, to control the display configuration, live video links and graphical overlays and to input information using the hard-wired switches and the touch-screen display. In addition, exchange of input-control devices mounted to removable chair panels makes adaptation to multiple systems very fast, simple and cost effective.

Benefits:

- Modular and reconfigurable interfaces

- Operator training capability

- Man-machine interaction test platform

- Documented and operator reconfigurable

- Usable for standards generation

Technology:

The prototype system consists of a large multi-screen projection-TV system framed on both sides by several high-resolution TV monitors, stereo speakers, and a reconfigurable operator console and control chair module with various removable interface modules (i.e. joysticks, buttons, touch-screen, etc.). All are ergonomically mounted on a raised platform and integrated with the display and control electronics.

The embedded computing consists of multiple central processing unit (CPU) racks to operate the consoles and to house the remote system-control and interface computing. The console computing consists of a real-time multi-processor CPU system operating under Windows NT and communicating with other hardware and interfaces via a network data delivery service (NDDS) communications protocol over Ethernet utilizing a serial or parallel interface. Adequate rack space is also provided for video recorders and other computing platforms such as Silicon Graphics and SUN Workstations. All hardware systems support the C-based programming environment for the re-programmable operator, interfaces and displays. Compatibility with other DOE remote systems, console and controller systems was enforced at the hardware and software level.

Project Conclusion:

The development of the console hardware and software interfaces was accomplished during a 23-month program starting in June 1996, and included a human-factors study followed by system design and prototyping. Subsequently, a lengthy performance acceptance testing period was completed at Carnegie Mellon University (CMU) and a final demonstration was performed at the International Union of Operating Engineers (IUOE) in Beckley, WV during April 1998.

The operator console system will continue to be used by the IUOE for operator training. Then, the system will be deployed to various large cleanup sites for the operation of remote and robotic technologies slated for deployment across the DOE complex. Use of the system in one or more scheduled large-scale demonstrations (LSDs) is currently being contemplated.

Contacts:

The Field Robotics Center (FRC) at Carnegie Mellon University's Robotics Institute has been developing field-worthy robot prototypes for remote and hazardous environments for over 10 years. The FRC is currently performing contract work for the DOE, NASA, ARPA, and the DOD among others. For information on this project, the contractor contact is:

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